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Arm range and/or moment limiting device for elevator platforms.

The device includes the presence of a microprocessor by means of which the maximum permissible arm range curves can be obtained and memorized through the machine itself. In this way the device can be installed on any machine without the need for prior knowledge of its geometrical configuration.

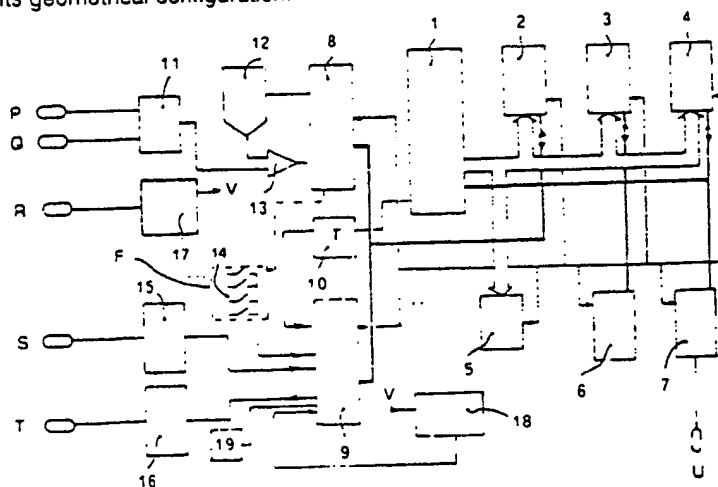


FIG. 4

## "ARM RANGE AND/OR MOMENT LIMITING DEVICE FOR ELEVATOR PLATFORMS"

The present invention refers to a device for limiting arm range and moment on elevator platforms.

An important problem with elevator platforms is the constant check that has to be kept on the operating conditions under which the hoisting structure is functioning, in order to prevent the occurrence of working configurations and load conditions involving risks of overturning and/or permanent deformation of the elevator's mechanical parts.

Some well-known ways of doing this include electromechanical limiting devices using chains, cams, microswitches, proximity switches etc., but these have been found insufficiently accurate and reliable.

Other well-known measures use limiting devices that include a central electronic unit which can:

- identify by means of sensors the lengths and angles of the arms supporting the platform and/or the overturning moment to which the structure is subjected because of its geometrical form and load conditions;
- compare the values so identified with previously stored maximum values to enable automatic action to be taken on the controls of the machine once the latter values are reached.

The drawback to these devices is that the maximum tolerable values stored in the electronic unit (based on figures for maximum tolerable range and moment supplied by the makers) are found, on testing, to be not fully suited to the machine (even if the machines on which the devices are installed are of the same model, no two machines ever being exactly alike), therefore requiring difficult adjustments when the machine is in working conditions.

These devices require the setting of sensors with the machine in working conditions, that is an operation not only time-consuming but rather unreliable.

The invention here described aims at overcoming the above drawbacks. One of its advantages is that sensors can be set and maximum working curves memorized directly with the machine in working conditions by simple operations requiring no instruments. Another advantage is that the limiting device can be designed without reference to the characteristics of the machine on which it is to be installed so that it can be applied to any machine whatever its geometrical configurations (arm length and angles) and its permissible working modes (permissible loads and working positions) may be.

According to a preferred version in which it

may be realized, reliability is increased by inclusion of circuits for diagnosing possible malfunctioning or errors.

To fulfil these aims the device according to the invention comprises a central electronic unit able to:

- store data of the maximum working curves;
- process signals received from the sensors placed to identify the working conditions of the machine, especially length and angular positions of the arms and the overturning moment;
- process and compare the above signals with the maximum tolerable values, calculated through the maximum curves already stored;
- control the machine in accordance with the results of these comparisons.

The same device is characterized by the fact that:

- the electronic unit is equipped with a control device that records, in a non-destructive readout memory, the values of signals received from the above sensors, these values being recorded as the maximum operational values the machine can withstand;
- storage of maximum curve values in the electronic unit is done by placing the machine in a sufficient number of critical working positions and then, for each critical position and using the above control device, storing the corresponding critical values indicated by the sensors.

Reference is made in the claims to further preferred forms of realization.

The characteristics of the invention will be made clearer by the following description and by the attached drawings illustrating a non-limitative example of its realization in which the various figures show:

Fig.1: A truck-mounted type of elevator platform;

Fig.2: Diagram of the limiting device and of the main units connected to it;

Fig.3: Some maximum operational curves supplied by makers of elevator platforms;

Fig.4: Functional block diagram of the electronic microprocessing unit according to the invention.

Fig.1 shows an elevator platform of the truck-mounted type on which a limiting device for arm range and moment is installed. Electrical connections between the device's central electronic unit and the outlying units linked to it are seen in Fig.2. The meaning of the component parts indicated in these two figures are explained below:

A. central electronic unit (usually encased in a shock and dust-proof container) the purpose of

which is to store data concerning the machine's maximum operation curves, process signals received from the sensors and carry out automatic control of functions:

H. cable, one end of which is fixed to the extensible end of the telescopic arm I, the other being wound in the servo cable coiler of sensor B:

B. arm extension and inclination sensors (usually housed in a single container) for measuring the extension of arm I and its inclination during operations (the extension sensor is substantially sensitive to rotation of the supporting pin of a servo-assisted cable coiler which keeps the unwound part of cable H under constant tension and coils or uncoils said part as the extension of arm I varies; the inclination sensor measures inclination of arm I in relation to rotation of a pin - held constantly in place by the force of gravity - during the various inclining movements made by the arm:

C. inclination sensor (also gravitational) housed in a dust-proof container and used separately from B to control the moment;

G. hoisting cylinder for regulating arm angle when the machine is working;

D. pin-type loading sensor used to determine the thrust exercised by the hoisting cylinder and which replaces the upper or lower articulation pin (see dotted line in Fig.1) of said cylinder:

E. differential pressure transducer which can be used as an alternative to sensor D to detect, by means of the hydraulic pressures present in the chamber of the cylinder (measured at the ends of the same), the degree of thrust exerted by said cylinder:

F. panel (installed if required on the platform) for checking and visualizing working conditions (warning and machine-locking light, acoustic warning, moment and arm range visualizer):

L. 12 24-volt feed battery.

Fig.3 shows an example of maximum operational curves (diagram of permitted arm range) supplied by the makers of elevator platforms.

Curve D'C'B'A'G' diagrammatically represents permitted arm range under a platform load of 200 Kg; curve D'B'F' represents permitted arm range under a load of 300 Kg, and curve D'C'E' represents permitted arm range under a load of 400 Kg. These diagrams apply to any position assumed by the turret (for rotation round its own axis) as long as the supporting base of the machine can be considered substantially symmetrical to said axis. If not, the maximum working curves vary not only with changes in load but also with variations to the supporting base of the machine (the degree to which stabilizing transoms placed at the base of the machine are pushed in or pulled out) and to turret orientation. In the ordinary way therefore, the number of maximum operational curves needed

must suit the machine's possible working conditions (turret orientation, permitted load, transom positions). Each time there is a change in conditions, the relevant maximum curve is automatically chosen by means of microswitches -sensitive to these changes - mounted on the machine.

Fig.4 illustrates a possible configuration of the central electronic unit according to the invention, the blocks being placed to represent:

1. Central processing unit;
2. RAM memory for operational purposes;
3. EPROM memory where the electronic unit's operational program is stored;
4. EPROM memory storing value charts of maximum curves and parameters used in selecting which to use;
5. Internal decodifier;
6. Clock;
7. Serial interface type RS-232 for possible connections to a remote device U for data visualization and preselection;
8. Peripheral gate for transit of analogical type signals;
9. Peripheral gate for transit of ON OFF signals;
10. Timer signalling device for computer gone "crazy", cyclically zero-set by a periodical signal from the CPU; if this signal is not received by the pre-established time, the device actuates machine locking controls;
11. Multiplexer which receives, from P and Q, the analogical signals sent by the inclination sensors and by those for arm extension and moment;
12. Digital analogical converter;
13. Comparator;
14. Selector mounted, if required, in the control panel F to enable control functions to be exercised or operational modes to be selected as an alternative to the selection which may be made by the control signals reaching 15 from S;
15. Input interface for ON.OFF signals indicative of outside conditions, received from S and emitted by external microswitches that identify changes in turret orientation zones, in zones of transoms extension and in load values;
16. Output interface for emitting ON OFF control signals to external relays particularly relays for pre-alarm and machine locking (indicated by T);
17. DC-DC feeder converter for converting battery voltage from R to voltages for feeding the various circuits;
18. Voltage comparator for controlling output voltages from 17 and for emitting alarm and/or machine locking signals if voltages exceed certain limits;

19. Panel inside the central electronic unit carrying control devices (button switches etc.) and LEDs to use for initial setting of sensors and for initial measurements and storage of maximum curve values.

Limiting device operation may be described as follows. When this device is adjusted for the first time, with the machine in working conditions, the operations of monitoring and storage are first put into effect by activating the microswitches present in 19. By means of the monitoring process, initial sensor setting is carried out as follows: taking the inclination sensor as an example, the arm is first inclined at its minimum angle. The setting control is then actuated (by rotating the related transducer) until the signal emitted by the inclination sensor reaches a value conventionally assumed by the electronic unit as zero, and this is shown in 19 by a LED (minimum LED) lighting up. The setting control is then locked in this conventional zero position. The arm is next moved to its maximum angle of inclination and in that position a button switch in 19 is depressed to allow the output signal from the sensor to be stored (in 4) as the maximum angle value. This setting procedure not only enables operational sensor scales to be worked out simply and quickly but also makes it possible to replace the transducer itself quite easily in the event of failure. If the sensor is in fact replaced, it will only be necessary to move the arm into its minimum angle position and then rotate the setting control until the LED (for minimum) lights up; the arm will then be moved to its position of maximum inclination, and adjustments made to a trimmer mounted on the circuit card (by means of which the reading scale of the sensor's output signal can be varied) until it is seen that the value of the sensor's output signal corresponds to the maximum angle value initially stored. When this value is reached a second LED (maximum LED) lights up in 19.

A similar procedure for setting and replacement is applicable to the other sensors as well.

When all sensors have been set, operating conditions for "storage" are put into effect making it possible to store "angle-extension/moment" data relating to permitted range curves in memory 4. Storage procedure consists simply of making the arm do the maximum range curve under actual load conditions (it being possible to identify this curve by noting how arm movement affects the stabilizing transoms). For example, this can be done by starting from the maximum angle, moving towards the minimum and stopping every 10 or 15 degrees (perhaps at even smaller intervals at the points of major interest); arm extension or load is varied at each angle until the maximum range or moment is reached; at this point a storage key in

19 is depressed to store the maximum angle-extension moment values and, if desired, the corresponding pre-warning values as well (based on the former, to which certain percentage safety margins are deducted). It should be noted that this type of storage already takes into account the arm bending that occurs under actual operating conditions and thus avoids the further adjustments of working curves normally required by limiting devices as at present known.

Data so stored form a chart identifiable in store by a univocal configuration of limit stop signals originated in the above-mentioned microswitches used for identifying the various operating conditions (turret position, permitted load, position of the stabilizers) and, in this way, a set of charts can be prepared and called up automatically when certain working conditions cause these microswitches to be actuated. By a suitable arrangement of selecting microswitches present in 19, the following operations can be carried out during the storage process:

- storing values of maximum arm extension or of moment;
- storing pre-alarm values of arm extension or of moment;
- a step-by-step check on stored values;
- cancellation of each step or of the whole chart.

When the sensors have been set and the maximum angle-extension-moment data have been stored in 4, installation of the limiting device is complete and the machine is ready to go into use.

When the machine is in operation, controlling action by the device may be described as follows: signals relating to arm inclination, arm extension and the moment, continuously identified by the sensors, arrive at the central processing unit. According to the value of the angle signal this unit chooses a pair of angular values stored in 4 which include the angle identified. Pre-stored values for maximum arm extension, maximum moment and pre-alarm correspond to these angular stored values; by means of linear interpolation the control function then works out the corresponding intermediate arm extension value permitted and the related pre-alarm value. By comparing the actual arm extension figure with the above values, the device operates a pre-alarm relay when arm extension lies between the pre-alarm (slow-down) value and the maximum admitted value (which locks the machine) while, when arm extension exceeds the maximum permitted value, the device operates the locking relay.

Reliability of the device is increased by the presence of a circuit for diagnosing possible malfunctioning or errors. In fact by means of unit 18, in Fig. 4, any discrepancies in values of feed voltage to the electronic circuits can be identified and a

warning given.

The signaler time 10 makes it possible to locate malfunctioning in the processing circuit causing the machine to lock.

The system is made even more reliable by internal software for diagnosis that maintains a watch on the internal circuits and on the sensors mounted on the machine, to make sure they work efficiently. The values of signals received from the angle sensor are checked at regular intervals to ensure their remaining within the limits of tolerance: if damage occurs to any connecting cables or to the transducer itself, the locking system comes into effect. The same kind of control is maintained on the signal from the arm extension sensor.

A further check to see that recorded data are correct is made each time the central electronic unit is switched on, and at regular intervals during work, by means of a specially devised check-sum routine: if any discrepancies emerge the machine is immediately locked.

### Claims

1. Arm range and or moment limiting device for elevator platforms, of the type comprising a central electronic unit able to:

- store data of the maximum working curves,
- process signals received from the sensors placed to identify the working conditions of the machine, especially length and angular positions of the arms and the overturning moment,
- process and compare the above signals with the maximum tolerable values, calculated through the maximum curves already stored,
- control the machine in accordance with the results of these comparisons,

characterized by the fact that:

- the electronic unit is equipped with a control device that records, in a non-destructive redout memory, the values of signals received from the above sensors, these values being recorded as the maximum operational values the machine can withstand;

- storage of maximum curve values in the electronic unit is done by placing the machine in a sufficient number of critical working positions and then, for each critical position and using the above control device, storing the corresponding critical values indicated by the sensors.

2. Limiting device as in claim 1 characterized by the fact that, for each working position assumed by the machine, the CPU present in the central electronic unit identifies the stored critical angular values immediately preceding and immediately following the angular value identified by the inclination sensor and, from these, obtains, by linear

interpolation of the values of maximum arm extension and of the moment associated therewith, the maximum tolerable value for arm extension and for moment, corresponding to the angular value identified by the sensor.

3. Limiting device as in claim 2, characterized by the fact that the central electronic unit is equipped with:

- a second control device which records in a non-destructive redout memory the values of the signals of start of travel and of end of travel received from the sensors,

- two indicators which, on becoming active, denote receipt of signals from the sensor, corresponding to the above-mentioned values of start and end of travel,

as well as by the fact that, before sensors are set, a conventional value of the start of travel signal is previously entered in the memory, for each sensor, and that, when the control device is put into operation for the first time, the transducers are calibrated in their start of travel position so as to cause activation of the above mentioned corresponding indicator while, when in their end of travel position, the above mentioned second control device is actuated in such a way as to record, in the memory, the value of the corresponding end of travel signal.

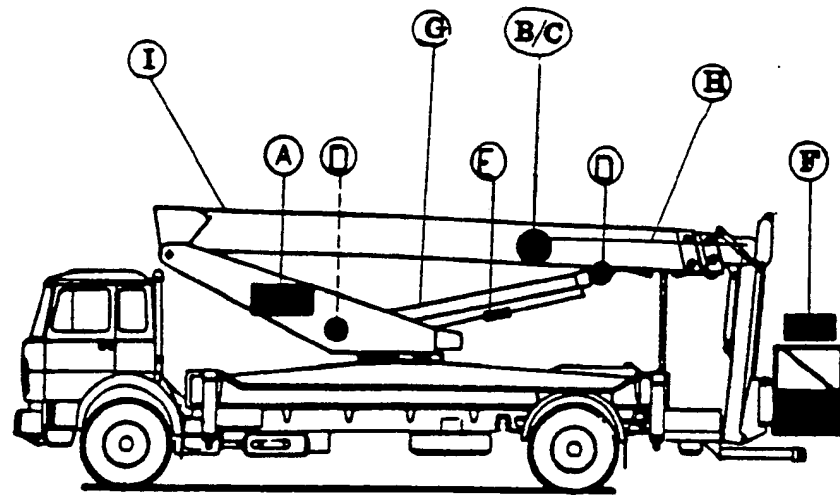


FIG. 1

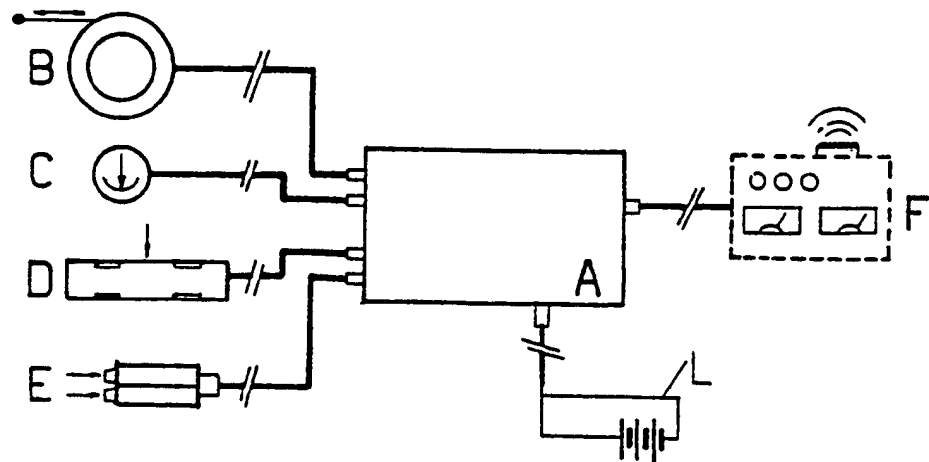


FIG. 2

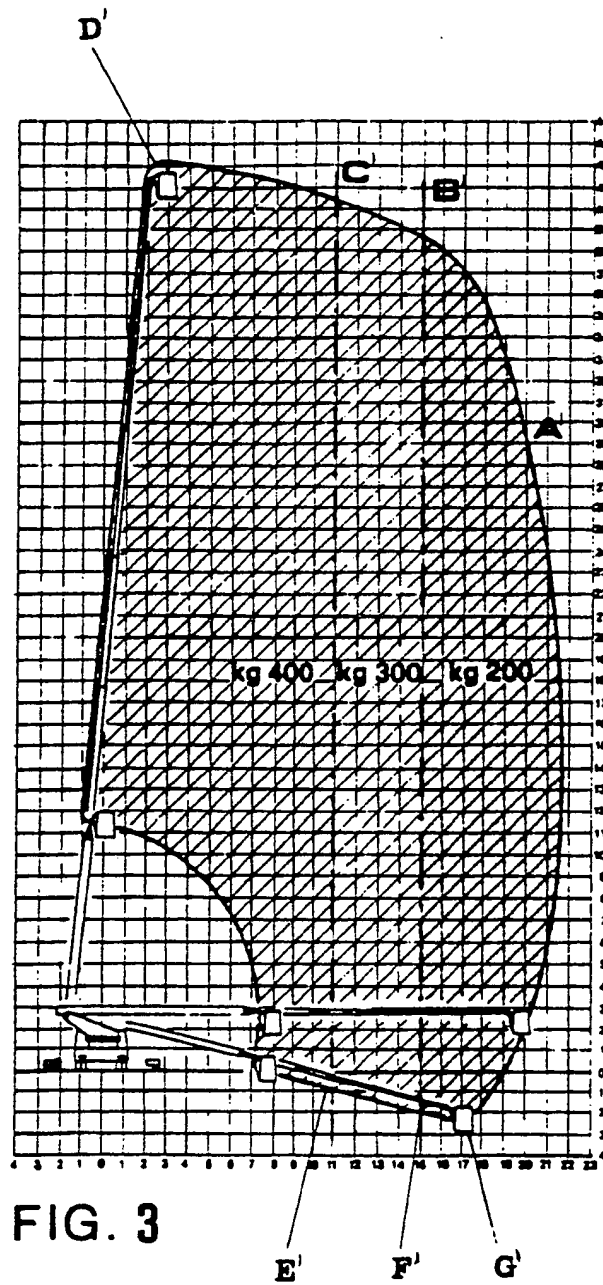
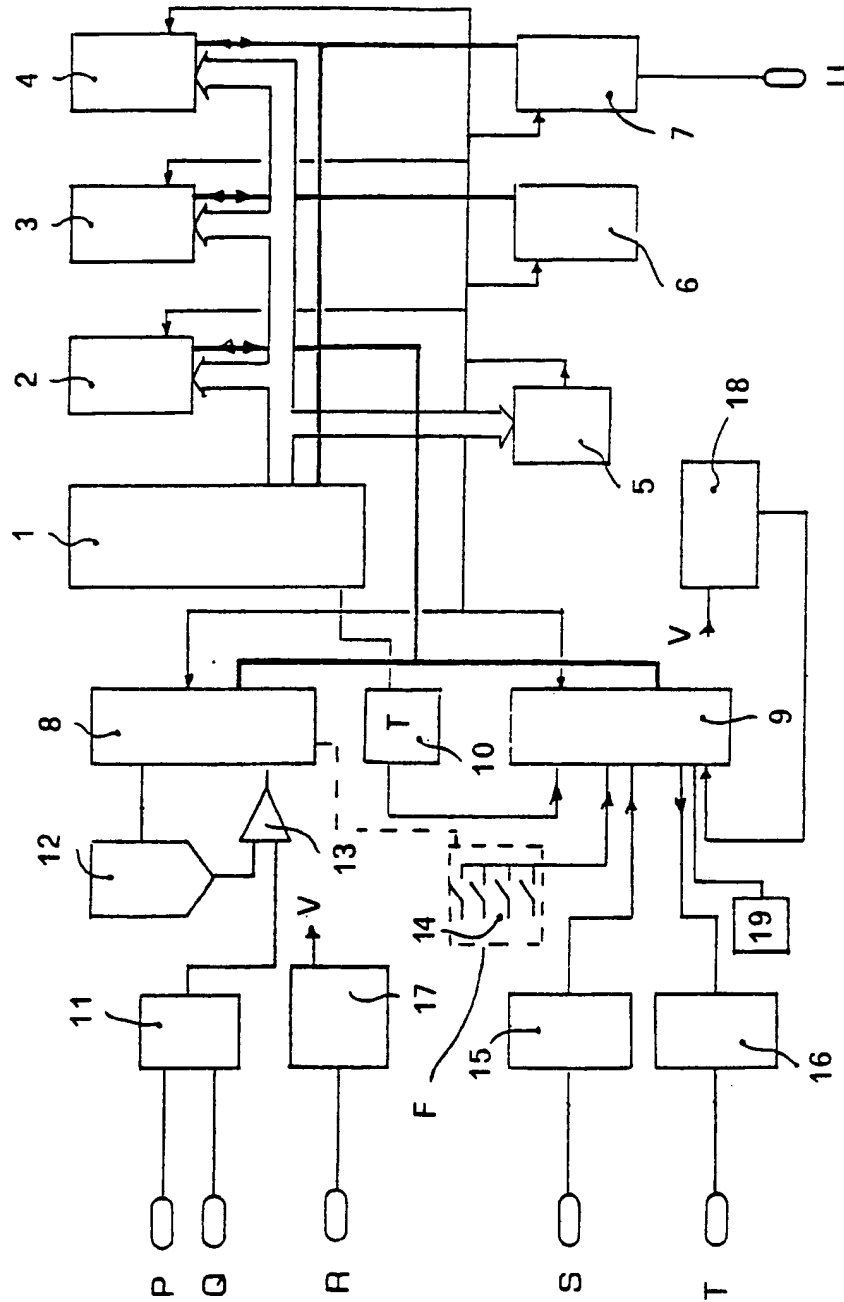


FIG. 3



**FIG. 4**



European Patent  
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# EUROPEAN SEARCH REPORT

Application Number

EP 87 20 1519

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
Y	DE-A-2 641 082 (KRUPP GmbH) * Figure; page 3, lines 1-14; page 4, lines 1-24 *	1	B 66 F 17/00
Y	DE-A-1 756 844 (VEB SCHWERMASCHINENBAU) * Figures; page 1, lines 11-14; page 2, lines 3-11, 22-29; page 3, lines 1-5 *	1	
A	DE-A-2 910 057 (L. PIETZSCH) * Figures; page 3 *	1,2	
A	DE-A-2 032 968 (KRUPP GmbH) * Figures 2,5; claim 1 *	1	
A	DE-A-3 420 596 (PIETZSCH GmbH) * Figure; page 4, line 17 - page 5, line 6 *	1	
A	DE-A-3 341 287 (KRÜGER GmbH) * Figures; abstract; claim 1 *	1	
A	FR-A-2 320 894 (FORNEY INTERNATIONAL INC.) * Figures; page 8, lines 20-31 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl. 4) B 66 F B 66 C
A	FR-A-2 351 395 (PYE ELECTRONIC PRODUCTS LTD) * Figures 1-5; claim 1 *	1	
A	FR-A-2 256 101 (D. BIRON)		
A	DE-A-2 013 388 (L. PIETZSCH)		
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 28-06-1988	Examiner GUTHMULLER J.A.H.
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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